ELSEVIER
CrossMark
Available online at www.sciencedirect.com
ScienceDirect
Procedia Earth and Planetary Science 11 (2015) 195 – 197
Procedia
Earth and Planetary Science

Global Challenges, Policy Framework & Sustainable Development for Mining of Mineral and Fossil Energy Resources (GCPF2015)

Iron Ore Recovery from Low Grade by using Advance Methods

Rachappa S.*, Prakash Y., Amit

HR/AH Iron ore mine, M/S Doddanavar Brothers, Hiremagi- 587 112 Bagalkot, Kaarnataka, India; hrmines@doddanavarbrothers.com

Abstract

With increasing global demand of iron ores due to the huge requirement of steel all over the world, important iron ore producing countries have increased their production by initiating steps to utilize the low-grade iron ores, fines and slimes. The main difficulty in processing and utilization of low-grade iron ores primarily stems from their mineralogical characteristics as well as the soft nature of some ores and their high silica content. Thus, beneficiating the low-grade iron ores to remove the gangue minerals and enhancing their grade is an attractive proposition today. Among the known iron deposits in Karnataka, many are of low-grade which require beneficiation to produce an acceptable feed for steel making plants.

Peer-review under responsibility of organizing committee of the Global Challenges, Policy Framework & Sustainable Development for Mining of Mineral and Fossil Energy Resources.

Keywords: iron ore; silica content.

1. Introduction

With increasing global demand of iron ores due to the huge requirement of steel all over the world, important iron ore producing countries have increased their production by initiating steps to utilize the low-grade iron ores, fines and slimes. The main difficulty in processing and utilization of low-grade iron ores primarily stems from their mineralogical characteristics as well as the soft nature of some ores and their high silica content. Thus, beneficiating the low-grade iron ores to remove the gangue minerals and enhancing their grade is an attractive proposition today. Among the known iron deposits in Karnataka, many are of low-grade which require beneficiation to produce an acceptable feed for steel making plants.

Main difficulty in processing and utilization of low grade iron ores primarily stems from their compositional characteristics as well as the soft nature of some of the ores and their typically high alumina content. The composition of the Indian iron ores is typified by high iron content with relatively

* Corresponding author. Tel.: +0-000-000-0000 ; fax: +0-000-000-0000 .
E-mail address: author@institute.xxx

Peer-review under responsibility of organizing committee of the Global Challenges, Policy Framework & Sustainable Development for Mining of Mineral and Fossil Energy Resources.
doi:10.1016/j.proeps.2015.06.024

higher amount of alumina (as high as 10% to 15%). The high alumina and silica pose serious operational problems during sintering and subsequent smelting in blast furnace. High alumina in iron ore and sinter leads to viscous slag formation during smelting, that in turn requires a high coke rate. There is a vast scope of this work in India as the alumina affects the quality of blast furnace burden in a variety of ways. It has adverse role on sinter strength and degrades reduction properties. It causes enhanced slag volume, viscous slag formation, decrease in productivity, increase in fuel rates in the blast furnace and higher energy consumption. Thus removal of alumina and other deleterious elements from iron ores leads to better sinter product with higher reducibility, lesser slag formation and fuel consumption, better slag separation which ultimately leads to higher cost efficiency, higher blast furnace productivity and better quality of steel. Thus, beneficiating the low grade iron ore to remove the gangue minerals and enhancing its grade is a prospective proposition today.

If ore contains appreciable amount of sulphide minerals, these should be removed by froth flotation prior to gravity concentration. Jigging is widely used for ores and minerals where flotation is not effective and for treating large volume material and for economic reasons where situation detects the least expenditure of money. Jigs are cheap to operate, easy to assess and inspection but require much water. Since the fines are not treatable in jigs, they do not provide a complete solution of any mineral dressing problem.

2. Experimental

Hematite is the predominant constituent of the sample while goethite/limonite is noticed in the minor amounts. Quartz is the main gangue mineral present in predominant proportion. Hematite is fine to medium grained and arranged in bands alternating with those of quartz. Fine to medium sized scattered grains of hematite are seen as inclusions. Very fine crowded inclusions of hematite are generally seen within the groundmass of quartz and vice versa. Quartz is very fine to medium grains and occurs as irregular patches. At -65 mesh size about 70% of the quartz grains are free from interlocking of hematite and remaining are present either as inclusions in hematite or as very fine interlocking with hematite.

Gravity, magnetic separation and floatation are the ore dressing techniques deployed to upgrade the sample. Magnetic separation did not produce any encouraging results.

Gravity separation i.e., tabling of the received sample ground to -65 mesh followed by regrinding the table middlings to all -100 mesh and subjected to tabling, produced a composite table concentrate assaying 60.77% Fe(T), 11.18% SiO_2 with an iron recovery of 44.5(Wt% yield being 25.87).

Reverse flotation of quartz at a grind of -100 mesh employing coco amine acetate as collector produced a non float fraction assaying 51.25% Fe(T) with a Fe recovery of 56.8% (Wt% yield 39.07).

The complex interlocking of quartz with hematite i.e. dotted mass, intermixing upto very fine size of 2-5 microns, filling cracks and fissures in hematite is very difficult to liberate. In addition, the inclusion of hematite in quartz and soft nature of the hematite as compared to quartz precluded the production of high grade concentrate with high recovery.

A low-grade iron ore sample of Karnataka region was obtained for detail studies. The received hematite samples were thoroughly mixed and representative sample was drawn by conning and quartering method for different characterization, mineralogical and beneficiation studies. The size analysis of the representative sample was carried out by wet sieving method. The complete chemical analysis of the bulk sample and different size fractions obtained from the size analysis studies were determined by wet chemical and X-Ray Florescence Technique (XRF). The closed size fractions for experimental studies were prepared by stage crushing in laboratory jaw and roll crusher.

3. Mineralogical studies

Iron ore samples are hard massive, laminated, porous, biscuity and powdery in nature. The minerals like kaolinite, gibbsite and fine grained goethite (ochreous/earth goethite) frequently occur as surface coatings of the iron ore lumps. Ore microscopic studies indicated that the hematite grains are of different types viz; microplaty, lacy and vermicular and specular hematite. The martite grains are euhedral and subhedral in nature. The precursor magnetite grains have been completely changed to martite. The martite grains have also been recrystallised to granular grains of 25-35 micron size. In many samples martite and microplaty hematite grains (max. length of 25 μm) form dense aggregates with minor amounts of voids (<5%). Martite grains also occur as dissemination within the dense microplaty aggregates. Coarse specular hematite grains occur in the voids. Vitreous and ochreous goethites are abundant in many iron ore samples. Goethite fills up the voids and fractures partially or completely in iron ores. The sizes of voids vary from few microns to few mm across. Hematite of varying sizes and shapes occur as inclusions within the goethite. It occurs as massive mass, crusts, colloform bands and fibrous grains. Vitrous goethite is grey to dark grey in colour; ochreous/earthy goethite is black to dark grey and composed of ultra fine crystallites. The aluminous minerals, kaolinite and gibbsite, are fine grained and occur in intimate association with ochreous goethite.

4. Results and conclusions

4.1. Characterization of the ore

Mineralogy of the ore: Using X-Ray Differential Analysis, it was found that the iron ore sample consisted of goethite, hematite, quartz, calcite kaolin and feldspar. The major constituents were goethite as an iron mineral and quartz as a gangue mineral, and the rest were minor minerals. Under the optical microscope, it was observed that the iron minerals and quartz are finely disseminated. The ore exists in the form of oolitic and pesolitic texture.

Liberation study: The degree of liberation of the iron minerals was studied by the point counting technique. Polished sections of the different size fractions were prepared and studied under the microscope in reflected light mode. Both the free particles of iron minerals and the grains of iron minerals locked with gangue minerals in the microscope view were counted and the percentage of free iron minerals grains relative to the sum of the two types of particles was observed.

References

1. BURT.R, 1999, The role of gravity concentration in modern processing plants, Minerals Engineering 12, 1291–1300.
2. FARAGHALY, M.G., 2002, *Beneficiation of El-Gedida Barite Iron Ore*, Journal of Engineering Science 30, 779–812.
3. SVOBODA, J., 1994, The effect of magnetic field strength on the efficiency of magnetic separation,Mineral Engineering 7, 747–757.
4. Mukherjee, A.K. and Mishra, B.K. 2006, Int. Journal of Mineral Processing vol.81, 3, pp.187.
5. Yang, David C., Reenan, Ricus van. and Bhimsan, Vima, 2003, Journal of Minerals and Material Characterization & Engineering. vol. 2, No.2, pp137.